

The Impact of Climate Literacy and Financial Literacy on Consumer Willingness to Decarbonise

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Abstract

Consumers' willingness to decarbonise depends on their understanding of both climate change and financial concepts, though the relationship is complex. We conducted a comprehensive survey with 1,079 representative Australians, aiming to understand how their climate literacy and financial literacy influence behavioural willingness to reduce their carbon footprint. To help answer this question, we created a new, more comprehensive measure of climate literacy. The study revealed that participants' climate literacy was positively related to their willingness to decarbonise. In contrast, financial literacy was negatively related to their willingness to decarbonise, a relationship that was moderated by climate literacy and environmental values. Both individual and collective efficacy played significant mediating roles in the relationship between climate literacy and willingness to decarbonise, while only individual efficacy was a significant mediator in the relationship between financial literacy and willingness to decarbonise. This research provides a novel understanding of the distinct roles that different types of literacy play in willingness to decarbonise and highlights efficacy as an underlying mechanism.

Keywords

climate literacy, financial literacy, efficacy, environmental values, willingness to decarbonise

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Introduction

The looming threat of climate change poses unprecedented challenges to global sustainability and human well-being (IPCC, 2023). With rising temperatures, extreme weather events and ecological disruptions becoming increasingly prevalent, urgent action is needed to mitigate the impacts of climate change and transition towards a more sustainable future (Rockström et al., 2017). To address climate change, many countries have put in place emission targets and plans to get there. For example, the UK is targeting net zero by 2050 by focusing on phasing out coal power, promoting electric vehicles and investing in renewable energy and green technologies (Department for Business, Energy & Industrial Strategy, 2021). Similarly, the United States has set a goal of achieving net-zero emissions by 2050 (United States Department of State & Executive Office of the President, 2021). Meanwhile, Australia has established a Net Zero Plan with the goal of reducing greenhouse gas emission levels by 43% by 2030 compared to 2005 levels (Australian Government, 2022). These targets and plans require comprehensive efforts at both societal and individual levels. Thus, understanding the drivers of behavioural change is essential to encourage decarbonising actions (Whitmarsh et al., 2021).

Research aiming to understand what motivates individuals to engage in decarbonising behaviour has been a focal interest of scholars and practitioners (Hale, 2022). Factors that have been found to increase individuals' willingness to decarbonise include environmental concerns (e.g. Diekmann & Preisendörfer, 2003), social norms (e.g. Bamberg et al., 2015) and climate change risk perception (e.g. van der Linden, 2015; Xie et al., 2019).

Despite the burgeoning research on predictors of decarbonising action, gaps remain in our understanding of how climate literacy and financial literacy are related to individuals' sustainability behaviour (Kolenatý et al., 2022). For example, some research suggests that climate literacy is a key predictor of willingness to take decarbonising actions (e.g. Kolenatý et al., 2022). However, existing climate literacy measures often assess sectional components of climate literacy such as knowledge of scientific facts, which may explain the mixed findings on how climate literacy is directly or indirectly related to behavioural willingness (e.g. Carmi et al., 2015). For example, some studies found no direct relationship between climate change and climate action (Frick et al., 2004; P. Liu et al., 2020), while some found a direct positive relationship (e.g. Kolenatý et al., 2022).

Another type of literacy – and one that has been relatively overlooked in this literature – is financial literacy. We believe financial literacy is crucial to understanding willingness to decarbonise because decarbonising actions often involve financial decisions such as transitioning to an electric vehicle or purchasing solar panels. However, limited understanding exists of how financial literacy is related to willingness to decarbonise.

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In this study, we examined different dimensions of literacy – namely, climate literacy and financial literacy – to elucidate how they contributed to consumers' willingness to take decarbonising action. We also investigated the mechanisms underlying how climate and financial literacy might be related to behavioural willingness to decarbonise. Our research makes three major contributions. First, we introduced a new climate literacy measure that encompasses diverse components of climate change, including its causes, consequences, mitigation efforts and the organisations involved in advising on climate action. This combination of components allows for a more precise assessment of individuals' climate literacy and enhances our ability to understand its impact on behavioural willingness to decarbonise. Second, our research revealed a somewhat counterintuitive negative relationship between financial literacy and willingness to decarbonise. Third, it found evidence for efficacy as a mechanism underlying the relationship between both climate change and financial literacy and willingness to decarbonise, thereby uncovering a new avenue to encourage decarbonising action.

Literature review

Climate literacy and financial literacy: Precursors to decarbonising action

Literacy plays a critical role in shaping beliefs, attention, intentions and behaviours, serving as a foundational precursor to informed action (Bandura, 1982). For example, one study found that the levels of information-related literacy – the literacy to search and utilise the information to create new knowledge – were associated with proactive academic behaviours such as using library resources (Pfundt & Peterson, 2024). Similarly, individuals with greater scientific literacy were less likely to hold conspiracy beliefs, which reduced their engagement in conspiracy-congruent behaviours such as avoiding vaccination (Allred & Bolton, 2024).

The role of literacy in driving action is often explained by perceived efficacy, as individuals who understand key concepts and know how to act, feel more empowered to take meaningful steps (Bandura, 1977). For instance, prior studies found that climate literacy enhances perceived efficacy in addressing climate change, fostering confidence in the ability to contribute to mitigation efforts (N. Geiger et al., 2017). By providing individuals with foundational knowledge and skills, literacy influences how people perceive, prioritise and respond to complex issues, ultimately shaping their willingness to take action.

This principle – that literacy provides foundational knowledge and skills which shape perceptions, priorities and responses to complex issues, thereby influencing individuals' willingness to take action – is particularly relevant to decarbonisation efforts as they require individuals to engage with complex information about climate change in order to make informed decisions and adopt new behaviours. It is important, however, to recognise that different forms of literacy are relevant for predicting decarbonising action. For instance, climate literacy fosters awareness and understanding of environmental challenges, which can enhance engagement in decarbonising action (e.g. Carmi et al., 2015), while financial literacy can shape decisions related to investments in sustainable technologies or decarbonising practices (Filippini et al., 2024). Recognising these forms of literacy in the context of decarbonising action is essential for understanding and empowering consumers to adopt decarbonising behaviours that address climate change.

Climate literacy and willingness to decarbonise

Climate change knowledge and climate literacy are often used interchangeably in the literature (see Table 1). However, recent research by Pan et al. (2023) defined climate literacy as a broader concept than climate change knowledge. While the literature has not yet reached a full consensus on the definition of climate literacy (Kolenatý et al., 2022), we defined it as the level of knowledge about climate change combined with the ability to apply this knowledge in actions that are directly or indirectly related to addressing, mitigating or adapting to climate change (Hiser & Lynch, 2021; Milér & Sládek, 2011). Accordingly, we contend that climate literacy should encompass not only knowledge of the causes and impacts of climate change but also understanding of the appropriate mitigation and adaptation efforts to address it.

Most research suggests that climate literacy can increase willingness to decarbonise, with only a few studies suggesting a potential negative influence of climate literacy on willingness to decarbonise (e.g. Shi et al., 2015). This is because climate literacy enables individuals to understand the urgency of climate change and the severity of its impact (Meinhold & Malkus, 2005). It fosters a sense of responsibility for climate change, encouraging greater acceptance of climate change policies (Milfont, 2012; Pan et al., 2023). As a result, individuals are better equipped to make informed decisions about reducing their carbon footprint (P. Liu et al., 2020). However, existing measures of climate literacy do not adequately capture all the components of climate change knowledge and mitigation efforts identified in prior research. For example, so-called climate literacy measures range from those focused on diet-related knowledge (Morren et al., 2021) to household greenhouse gas emissions (Sharp & Wheeler, 2013) to knowledge of basic ecology (S. M. Geiger et al., 2019). A study by Pan et al. (2023) attempted to incorporate a broader range of knowledge, including the causes and consequences of climate change and climate change-related policy actions. However, their measure omitted the knowledge of climate change mitigation, which is the key driver of decarbonisation efforts (Shi et al., 2015). Table 1 summarises existing measures of climate literacy.

The narrow and limited scope of existing measures could result in the potential mixed findings in the literature where some research found no direct relationship between climate literacy and decarbonising action (Carmi et al., 2015; Frick et al., 2004), while some research found a positive and direct relationship between the two constructs (e.g. Kolenatý et al., 2022). Furthermore, most of the items in existing measures are relatively easy. For example, a recent measure developed by Pan et al. (2023) showed that most participants correctly answered the scale items, with the highest correct response rate exceeding 90%. However, such high correct response rates may indicate a failure to effectively differentiate those who are genuinely interested in and understand climate change from those who are not. This practice could even lead to the misinterpretation that most people are climate literate. To address this concern, we developed a new measure of climate literacy that incorporates knowledge about causes, impacts, mitigation responses and organisations involved. We also ensured that the items were neither too easy nor too difficult, resulting in an approximately normal distribution of response accuracy (see Appendix A).

Financial literacy and willingness to decarbonise

Financial literacy refers to '... the degree to which one understands key financial concepts and possesses the ability and confidence to

Table 1. Summary of Climate Literacy Measures.

Research	Causes	Consequences	Mitigation efforts	Organisations involved	Context	Example items
Bradley et al. (2023)					Subjective knowledge	'Overall, how much do you feel you know about climate change?' (1 = Nothing at All, 6 = Just about Everything)
Pan et al., (2023)	✓	✓		✓	Causes and consequences of climate change, Physical (general) knowledge, Human engagement (policy issues)	'Burning fossil fuels in industrial production releases large amount of carbon dioxide' (<i>cause and consequences</i>); 'The Sun is the primary source of energy for Earth's climate system' (<i>physical (general) knowledge</i>); 'Paris Agreement sets goals to limit the global temperature increase preferably to 1.5 degrees Celsius compared to pre-industrial levels' (<i>human engagement</i> ; True/False/Don't know)
Morren et al. (2021)			✓		Diet-related knowledge	'Replacing beef by chicken is more favourable for the environment than replacing beef by cheese'; 'Most healthy food choices are also sustainable food choices' (True/False)
P. Liu et al. (2020)	✓				General environmental knowledge	'Carbon dioxide contributes to the creation of the greenhouse effect' (True/False/I don't know)
Braun and Dierkes (2019)			✓		Human-environment system knowledge; Action-related knowledge; Effectiveness knowledge	'Which are coniferous trees?' (Response set: Beech tree/Douglas fir/Palm tree/Spruce; <i>system knowledge</i>); 'How can you contribute to a healthy environment?' (Response set: Wash your clothes less often/Use public transport/Use plastic cups/Eat more meat; <i>action-related knowledge</i>); 'How much water can you save when you take a shower instead of a bath?' (Response set: up to 500 liters/Up to 120 liters/Up to 70 liters/Up to 30 liters; <i>effectiveness knowledge</i>)
S. M. Geiger et al. (2019)					Basic Ecology	'What causes wind?' (Response set: The movement of the clouds/Differences in temperature and air pressure in the atmosphere/The moon's gravity/Ocean currents.)
Paço and Lavrador(2017)	✓				General environmental knowledge	'Diesel fuel pollutes less than unleaded fuel' (True/False)
Carmi et al. (2015)	✓				General environmental knowledge	'Global warming is caused by the hole in the ozone layer' (True/False/I don't know)
Díaz-Sieffer, et al. (2015)	✓	✓	✓		Human-environment system knowledge, Environmental action knowledge	'Which of the following gases has greater contribution to the greenhouse effect?' (Response set: Methane [CH ₄]/Nitrous oxides [NO _x]/Ozone [O ₃]/Water vapour [H ₂ O]/Carbon dioxide [CO ₂]); 'What are the effects of global warming?' (Response set: Thaw/Sea level rise/Drought/Species extinction/All the answers; <i>human-environment system knowledge</i>); 'Which action does not help to save energy costs in everyday life?' (Response set: Unplug all electrical appliances/Turn off electronic devices without unplugging/Close the doors and windows when the heating works/Install solar panels/Use the lowest amount of light possible; <i>environmental action knowledge</i>)
Shi et al., (2015)	✓	✓	✓		Physical knowledge, Causal knowledge, Action-related knowledge, Result-related knowledge	'CO ₂ is a greenhouse gas' (<i>physical knowledge</i>); 'Climate change is mainly caused by human activities' (<i>causal knowledge</i>); 'Turning off the power of electric appliances when they are not in use can save a lot of energy' (<i>action-related knowledge</i>); 'For the next decades, the majority of climate scientists expect an increase in extreme events, such as droughts, floods and storms' (<i>result-related knowledge</i> ; True/False/I don't know)
Sharp & Wheeler (2013)	✓				Household-related knowledge	'In the average household kitchen, which act do you think emits the most Green House Gases?' (Response set: cooking/chilling/dishwashing)

(Continued)

Table 1. (Continued)

Research	Causes	Consequences	Mitigation efforts	Organisations involved	Context	Example items
Milfont (2012)					Subjective knowledge	'How well-informed do you consider yourself to be on global warming and climate change?' (0 = not at all informed, 5 = somewhat informed, 10 = very well informed)
Polonsky et al. (2012)	✓		✓		General environmental knowledge; Carbon offset knowledge	'Most smog in our big cities comes from industrial plants (e.g. factories)' (<i>general environmental knowledge</i>); 'Carbon offset programmes may invest in activities that only reduce carbon in the future' (<i>carbon offset knowledge</i> ; True/False)
The present research	✓	✓	✓	✓	Causes of climate change, Consequences of climate change, Mitigation efforts, Organisations involved in climate change mitigation efforts	See Table 3.

manage personal finances through appropriate, short-term decision-making and sound, long-range financial planning, while mindful of the life events and changing economic conditions' (Remund, 2010, p. 284). Those with higher financial literacy tend to be better equipped to navigate future financial challenges and opportunities (e.g. de Bassa Scheresberg, 2013) and less likely to be in debt (e.g. Gathergood, 2012).

Decarbonising action often involves making financial decisions. Examples include using public transport, transitioning to an electric vehicle and electrifying one's house. Furthermore, for some consumers, the key reason to take decarbonising action could be for financial benefits rather than mitigating climate change impacts (Scheller et al., 2024). For example, many people invest in solar panels with high upfront cost because of a financial calculation that, in the long term, they will be financially ahead. To make such financial evaluations accurately, consumers are required to understand how to manage their money over time as they need to sacrifice upfront costs for long-term benefits. Some decarbonising actions may even necessitate financial assistance – for example, loans – which makes understanding consumers' financial decision-making of critical importance.

The role of financial literacy in influencing decarbonising actions remains underexplored, with most research focusing on financial benefits that can motivate such actions (e.g. Allen et al., 1993; Steg & Vlek, 2009); however, the findings are mixed. On one hand, some research has found that financial literacy is positively related to decarbonising action, such as recycling, among young adults in Brunei (Hasnul & Wasiuzzaman, 2024). On the other hand, Cho et al. (2024) explored the relationship between numeracy and attitudes towards climate change. Numeracy, defined as the ability to understand and interpret numerical information, is often linked to financial literacy due to its application in financial decision-making (Lusardi, 2012; Skagerlund et al., 2018). However, their findings suggest that numeracy does not inherently make individuals more likely to accept the scientific consensus on climate change. This is significant because recognising the scientific consensus is a critical cognitive foundation for supporting decarbonising action. These findings indicate that there may be no relationship between financial literacy, which involves task-oriented cognitive skills as numeracy, and willingness to engage in decarbonising actions.

We can envision two different (and opposing) relationships between financial literacy and willingness to decarbonise. The

argument for a positive relation is that decarbonising action involves financial decisions, and individuals with higher financial literacy should be better equipped to evaluate costs and benefits, allocate resources towards sustainable investments aligned with their financial goals (James et al., 2012), and navigate government incentives effectively (Australian Government, 2024a; Lusardi & Mitchell, 2008). By contrast, the argument for a negative relation is that financially literate individuals tend to maximise outcomes and minimise risks (Cokely et al., 2018; Traczyk et al., 2018) and may therefore avoid decarbonising actions involving any financial risks or large future financial uncertainties. Moreover, those with higher financial literacy may prioritise economic concerns over environmental considerations when making decisions, and this may further reduce their willingness to decarbonise (Bakan, 2024).

Efficacy and willingness to decarbonise

In the context of climate change, self-efficacy is often discussed as a potential mechanism underlying the relationship between literacy and behavioural willingness (e.g. Bostrom et al., 2019). Efficacy can be conceptualised at individual and collective levels. Individual efficacy refers to individuals' belief that they have ability to reduce their own carbon footprint, and that their actions will result in a meaningful outcome. Collective efficacy refers to individuals' belief that many others have ability to reduce their carbon footprint, and that the combined action of these many others will result in a meaningful outcome (Camilleri & Larrick, 2019).¹ The distinction between individual and collective level of efficacy is essential because it helps to delineate the possible pathways by which consumers may be motivated to engage in decarbonising actions. For example, individual efficacy may drive personal behaviours (e.g. driving an electric car) while collective efficacy could enhance engagement in community-based or large-scale initiatives where consumers believe that combined efforts can lead to meaningful changes (e.g. supporting a community solar bank).

Prior research suggests there exists a positive relationship between climate literacy and efficacy (e.g. N. Geiger et al., 2017). Specifically, one study found that greater knowledge of climate change was positively correlated with the efficacy level of individuals, which predicted their willingness to engage in climate actions (Xie et al., 2019). Presumably, when individuals possess a deeper

understanding of climate change, they may feel more capable of taking action, as this understanding reduces aversive feelings such as uncertainty (Bandura, 1977; Peterson & Pitz, 1988). Meanwhile, the literature indicates that financial literacy can enhance perceived efficacy in taking financial decisions (e.g., L. Liu & Zhang, 2021); however, how this relationship influences actions within the domain of climate change remains unexplored.

Environmental values

The concept of environmental values has been defined as the ‘endorsement of an ecological worldview’, which primarily refers to environmental concern and attitudes (Dunlap et al., 2000, p. 426). Environmental values are often grounded in moral and normative considerations, arising from a sense of what is ethically responsible or social expectations regarding environmental stewardship (de Groot & Steg, 2007; Steg & Vlek, 2009). Hence, consumers with strong environmental values tend to prioritise environmental concerns over personal interests, fostering positive attitudes towards pro-environmental behaviours (Rausch & Kopplin, 2021) and engaging in more decarbonisation efforts (Steg & de Groot, 2012). It is, therefore, plausible that environmental values can moderate the aforementioned relationships, and we explored the role of environmental values in these relationships.

Research questions and study overview

The present study aimed to examine the role of climate literacy and financial literacy in predicting willingness to decarbonise. Additionally, it investigated the possible mediating role of individual and collective efficacy and explored the moderating role of environmental values in the relationship between literacy and willingness to decarbonise. Accordingly, the research questions were as follows:

RQ1: How is climate literacy related to the willingness to decarbonise?

RQ2: How is financial literacy related to the willingness to decarbonise?

RQ3: To what extent do individual and collective efficacy mediate the relation between both climate literacy and financial literacy and willingness to decarbonise?

RQ4: To what extent do environmental values moderate the relation between both climate literacy and financial literacy and willingness to decarbonise?

Methods

A total of 1,079 participants, generally representative of the Australian adult population, completed a survey. Participants were recruited through an online panel called ‘Pureprofile’ in September 2023. The sample was 49.8% female, and the average age was 47.98 years ($SD = 17.53$). Although a significant proportion of respondents held higher education qualifications – such as a Bachelor’s degree (23.1%) and Master’s degree (10.2%) – a notable portion also reported high school completion or lower (21.7%). The median category for personal income was \$70,000 to \$99,999, and the median category for household income was \$100,000 to \$149,999. Full demographic information can be found in Appendix B. The median time to complete the questionnaire was 23.08 minutes. One attention-check question was included, and the participants who failed to answer correctly were directed out of the survey ($N = 43$).

Measures²

Climate literacy. We developed a new, 13-item questionnaire to measure climate literacy, aiming to better capture the understanding of climate change across four components: the causes of climate change, the consequences of climate change, individual-level mitigation strategies for climate change and organisations involved in addressing climate change. We created the items based on the information in public reports, published papers (e.g. Duffy et al., 2022; Xiu et al., 2018) and official websites of the organisations. Our primary goal for this climate literacy measure was to ensure that the questions were neither too easy nor too difficult, allowing the scale to exhibit a normal distribution. With this aim, five pilot studies were conducted (total $N = 250$) to finalise the set of items (see Appendix A for further details). The Q-Q plot (Figure 1) provides a visual representation of the new climate literacy measure’s distribution by plotting the observed quantiles of the scores against the theoretical quantiles of a normal distribution (Wilk & Gnanadesikan, 1968). The alignment of the data points along the diagonal reference line suggests that the scale scores are approximately normally distributed, supporting the aim of ensuring that the scores are evenly distributed.

Factor analysis for the climate literacy measure. Bartlett’s test of sphericity was also conducted to assess whether the correlation matrix of the 13 items was significantly different from an identity matrix. The test was statistically significant ($\chi^2(78) = 1,632.00, p < .001$), indicating that the observed correlations were sufficiently large for factor analysis. Furthermore, the Kaiser-Meyer-Olkin (KMO) test was performed to assess the adequacy of the sample for factor analysis. The overall KMO measure was 0.82, suggesting that the dataset was well-suited for factor analysis (Kaiser, 1974).

Finally, Exploratory Factor Analysis (EFA) was conducted on the 13 climate literacy items using the maximum likelihood method of extraction with the varimax rotation. The results revealed a two-factor structure where the four items measuring organisation-level mitigation efforts loaded primarily onto one factor and the remaining items loaded primarily onto a second factor (see Table 2). These two factors explained 44.55% of the total variance. Given that the correlation between the two factors was strong ($r = .49, p < .001$) and our definition of climate literacy encapsulated the organisations involved in mitigating climate change, we combined these two factors to create a single climate literacy measure. Participants received 1 point for each correct answer, resulting in a total score ranging from 0 to 13. The average score was 4.96 ($SD = 2.96$), and the reliability score for the items was 0.73 (see Table 3 for the final items).

Financial literacy. Financial literacy was measured by using the Financial Knowledge Scale (FKS) by Houts & Knoll (2020), which is an expansion of the 3-item financial literacy measure by Lusardi and Mitchell (2008). Three items were revised to align with Australian financial concepts, including ‘Housing prices in Australia can never go down’ (response options: true/false/I don’t know). The items are commonly used to measure financial literacy in the literature because they assess not only individuals’ understanding of financial concepts but also their ability to manage their financial resources. For example, the scale asks questions such as ‘Suppose you owe \$3,000 on your credit card. You pay a minimum payment of \$30 each month. At an Annual Percentage Rate of 12% (or 1% per month), how many years would it take to eliminate your credit card debt if you made no additional new charges?’ Hence, although the scale’s name may suggest a focus solely on knowledge, its items capture broader aspects of financial literacy by examining practical applications of financial understanding in real-world contexts. Participants received 1 point for each correct answer,

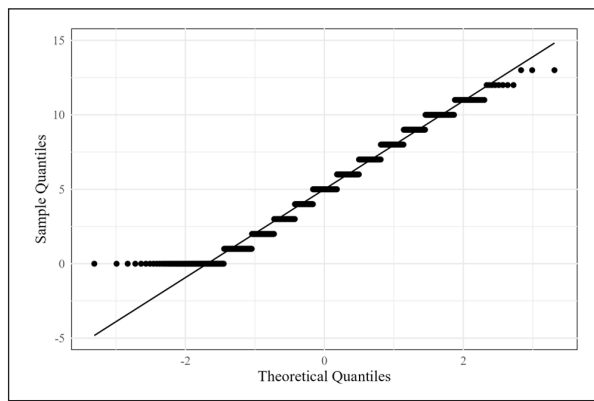


Figure 1. Q-Q plot for the climate literacy measure.

Table 2. Exploratory Factor Analysis (EFA) Results for the Climate Literacy Measure.

Climate literacy items	Component	
	1	2
Mitigation efforts 1	.700	.086
Mitigation efforts 2	.697	.151
Mitigation efforts 3	.635	.155
Consequences 1	.616	.182
Causes 2	.611	.156
Causes 1	.606	.202
Consequences 3	.584	.093
Consequences 2	.480	.254
Causes 3	.416	.393
Organisations 2	.176	.766
Organisations 3	.076	.741
Organisations 1	.182	.681
Organisations 4	.230	.673

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalisation.^a

^aRotation converged in three iterations.

Note. Primary factor loadings for each item are presented in bold.

thus a total score ranging from 0 to 10. The average score was 5.87 ($SD = 2.40$), and the reliability score for the items was 0.72 (see Appendix G for the full list of items).

Willingness to decarbonise. To measure willingness to take decarbonising actions, we adapted the items developed by Bradley et al. (2023) and provided a set of twenty-two decarbonising actions and asked participants to indicate the extent to which they are willing to take these actions to help reduce climate change. Examples of the actions include greatly reducing one's energy use, installing solar energy for one's home, using public transportation more often and participating in climate protests, rallies or other public demonstrations dedicated to fighting climate change. The items were rated on a 5-point scale where 1 indicated 'strongly disagree' and 5 indicated 'strongly agree'. Additionally, there was an option of 6, which allowed participants to indicate that the item was not applicable to them. For example, installing solar panels might not be applicable to those who are renting. In the analysis, responses of 6 were treated as missing values. Responses were averaged to produce an overall willingness to decarbonise score. The average score was 3.25 ($SD = 0.94$), and the reliability score for the items was 0.95 (see Appendix H for the full list of items).

Individual and collective efficacy. We measured individual and collective efficacy by assessing participants' perceived ability – either their own or that of others – to reduce their carbon footprint, as well as their belief that such reductions can contribute to addressing climate change. Individual and collective efficacy were measured using items adapted from Camilleri and Larrick (2019); two items asked about a participant's personal ability to reduce their carbon footprint (individual ability efficacy) and the extent to which this reduction would contribute meaningfully to addressing climate change (individual outcome efficacy). Additionally, we measured collective efficacy by asking about participants' perception of others' ability to reduce their carbon footprint (collective ability efficacy) and the potential meaningful contribution of such actions to addressing climate change (collective outcome efficacy). The items were rated on a 5-point scale, with 1 being completely unable (no contribution) and 5 being completely able (enormous contribution). The reliability score for the two items measuring individual ability efficacy and outcome efficacy was 0.65, which was slightly below the conventional threshold, but still sufficient to aggregate the items into a single variable, individual efficacy (Nunnally & Bernstein, 1994). Collective efficacy was also aggregated into a single variable, collective efficacy, with the reliability score of 0.76 for two items measuring collective ability efficacy and outcome efficacy (see Appendix I for the full list of items). The average values of individual and collective efficacy were 3.11 ($SD = 0.89$) and 3.26 ($SD = 0.95$), respectively.

Environmental values. Environmental values were measured by using the New Ecological Paradigm (NEP) Scale developed by Dunlap et al. (2000). An example item was 'If things continue on their present course, we will soon experience a major ecological catastrophe'. The items were rated on a 5-point scale, with 1 indicating 'strongly disagree' and 5 indicating 'strongly agree'. Responses were averaged to produce an overall environmental values score. The reliability score was 0.63, falling slightly below the conventional threshold yet remaining acceptable (Nunnally & Bernstein, 1994). The average score was 3.60 ($SD = 0.65$) out of 5 (see Appendix J for the full list of items).

Results

Means, standard deviations and correlations between the variables of interest are provided in Table 4.

Climate and financial literacy and willingness to decarbonise

Regression analysis. A multiple regression model was used to examine the effects of climate literacy and financial literacy on decarbonising action willingness. The regression model including both literacy variables as predictors was statistically significant ($F(2, 1,071) = 79.33, p < .001$, adjusted $R^2 = .127$). The analysis revealed that climate literacy positively predicted willingness to decarbonise ($b = 0.126, t(1,071) = 12.41, p < 0.001$). In contrast, financial literacy negatively predicted willingness to decarbonise ($b = -0.094, t(1,071) = -7.51, p < .001$). These observations suggest that, on average, individuals with a good understanding of climate change are more willing to take decarbonising action, whereas individuals with a good understanding of financial concepts are less willing to take decarbonising action. There was also a significant interaction between climate literacy and financial literacy on willingness to decarbonise ($b = 0.010, F(3, 1,070) = 55.02, p = .017$). Specifically, for those with high (vs. low) climate literacy, the negative effect of financial literacy on willingness to decarbonise was smaller or may even have reversed (see Figure 2).³

Table 3. Climate Literacy Measure.

Item category	Item number	Response set
Causes of climate change	Which of the following is the societal activity that contributes most to causing climate change?	
	1	o Livestock rearing (51%) o Oyster farming o Rice farming o Agroforestry o I don't know
	2	o Using electricity in buildings (35%) o Producing nuclear energy o Producing paper and pulp o Constructing solar panels and batteries o I don't know
Consequences of climate change	3	o Using fertilisers (33%) o Harvesting seaweed o Strip cropping o Backyard farming o I don't know
	Which of the following events is most likely to increase as a result of climate change?	
	4	o Food crisis (33%) o Growth of insect populations o Ozone layer depletion o Earthquake o I don't know
	5	o Diseases (28%) o Volcanic eruptions o Aurora o Radioactive decay o I don't know
	6	o Drought (49%) o Soil acidity o Solar eclipse o Ocean upwelling o I don't know
	7. Which statement is true about the 'Paris Agreement'?	
Organisations involved in climate change mitigation efforts	o The Agreement aims to establish long-term strategies to respond to climate change. (32%) o The Agreement imposes penalties for parties that violate its terms. o The Agreement provides climate finance to industrialised countries. o The Agreement aims to limit the temperature increase to 1.0°C. o I don't know	
	8. Which statement is true about the 'Intergovernmental Panel on Climate Change (IPCC)'? o The IPCC offers assessment reports on climate change and its impacts. (21%) o The IPCC undertakes new research about climate change. o The IPCC forces governments to change their policies in response to climate change. o The IPCC conducts educational programmes in schools about climate change. o I don't know	
	9. Which statement is true about the 'United Nations Framework Convention on Climate Change (UNFCCC)'? o The UNFCCC aims to stabilise greenhouse gas concentrations in the atmosphere. (22%) o The UNFCCC aims to reduce sea level rise. o The UNFCCC aims to map out shifts in ecosystems due to climate change. o The UNFCCC aims to mitigate public health risks due to climate change. o I don't know	
	10. Which statement is true about the 'Kyoto Protocol'? o The Protocol aimed to reduce greenhouse gas emission. (38%) o The Protocol focussed on human rights and equality. o The Protocol addressed deforestation prevention. o The Protocol focussed on reducing carbon dioxide, but not methane. o I don't know	
Mitigation efforts at individual level	For the average person trying to reduce their carbon footprint, which action would be the most effective?	
	11.	o Reduce electric clothes dryer usage by 1 hr (63%) o Reduce desktop computer usage by 1 hr

(Continued)

Table 3. (Continued)

Item category	Item number	Response set
		- o Reduce television usage by 1 hr - o Reduce vacuum cleaner usage by 1 hr - o I don't know
	12.	o Reduce plane travel by 500km (37%) - o Reduce car travel by 500 km - o Reduce train travel by 500 km - o Reduce bus travel by 500 km - o I don't know
	13.	o Reduce beef consumption by 1 kg (52%) - o Reduce cheese consumption by 1 kg - o Reduce pork consumption by 1 kg - o Reduce poultry consumption by 1 kg - o I don't know

Note. Correct responses are in bold, and the correct response rates are in parentheses.

Table 4. Descriptive Statistics and Correlations Between Key Variables. Means, Standard Deviations and Correlations with Reliability Scores.

Variable (min-max score)	M	SD	Cronbach's alpha	1	2	3	4	5
1. Climate literacy	4.96	2.96	.73					
2. Financial literacy	5.87	2.40	.72	.45**				
3. Individual efficacy	3.11	0.89	.65	.19**	-.09**			
4. Collective efficacy	3.26	0.95	.76	.18**	-.05	.79**		
5. Environmental values	3.60	0.65	.63	.40**	.15**	.22**	.27**	
6. Willingness to decarbonise	3.25	0.94	.95	.29**	-.06*	.67**	.60**	.34**

Note. M and SD are used to represent mean and standard deviation, respectively. Climate literacy ranges from 0 to 13, financial literacy ranges from 0 to 10, individual efficacy ranges from 1 to 5, collective efficacy ranges from 1 to 5, environmental values ranges from 1 to 5 and willingness to decarbonise ranges from 1 to 5.

* $p < .05$. ** $p < .01$.

Mediating effect of individual and collective efficacy

Climate literacy and willingness to decarbonise. To examine the mediating effect of individual and collective efficacy, parallel mediation analyses were conducted using the PROCESS macro (Hayes, 2022). A 95% bias-corrected confidence interval based on 5,000 bootstrap samples indicated that climate literacy was indirectly related to decarbonising action willingness through its relationships with individual and collective efficacy (individual efficacy: $b = 0.03$, $SE = 0.005$, 95% CI [0.020, 0.040], collective efficacy: $b = 0.01$, $SE = 0.003$, 95% CI [0.006, 0.018], total effect: $b = 0.09$, $SE = 0.009$, $p < .001$; see Table 5).

Financial literacy and willingness to decarbonise. Parallel mediation analyses were conducted using the PROCESS macro (Hayes, 2022) to examine the mediating effect of efficacy on the relationship between financial literacy and decarbonising action. The results with 95% bias-corrected confidence interval based on 5,000 bootstrap samples indicated that only individual efficacy was a significant mediator in the relationship between financial literacy and decarbonising action willingness ($b = -0.02$, $SE = 0.006$, 95% CI [-0.031, -0.007], total effect: $b = -0.024$, $SE = 0.012$, $p = .046$; see Table 5). The results suggest that individuals with a good understanding of financial concepts had lower beliefs in the effectiveness of their individual efforts in reducing their carbon footprint and addressing climate change, thus making them less willing to take climate action.

Moderating effect of environmental values

To explore the moderating effect of environmental values, moderation analyses were conducted using the PROCESS macro (Hayes, 2022). A 95% bias-corrected confidence interval based on 5,000 bootstrap samples indicated that environmental values did not moderate the relationship between climate literacy and willingness to decarbonise ($b = -0.006$, $F(1, 1,070) = 0.17$, $p > 0.1$). By contrast, the results revealed that environmental values significantly moderated the relationship between financial literacy and willingness to decarbonise ($b = 0.11$, $F(1, 1,070) = 37.19$, $p < .001$). Individuals with higher environmental values demonstrated a positive relationship between financial literacy and willingness to decarbonise, while those with lower environmental values showed a negative relationship between financial literacy and willingness to decarbonise (see Figure 3).

We examined the moderating effect of environmental values on the relationships between both climate and financial literacy and willingness to decarbonise via individual and collective efficacy. Results revealed that environmental values moderated the relationships between climate literacy and both types of efficacy (see Figure 4). The results also revealed that the path from individual efficacy to willingness to decarbonise was moderated by environmental values ($b = -0.14$, $F(1, 1,069) = 6.35$, $p = .01$), but no significant moderation was found for the path from collective efficacy to willingness to decarbonise (see Figure 4). The mediating effect of individual

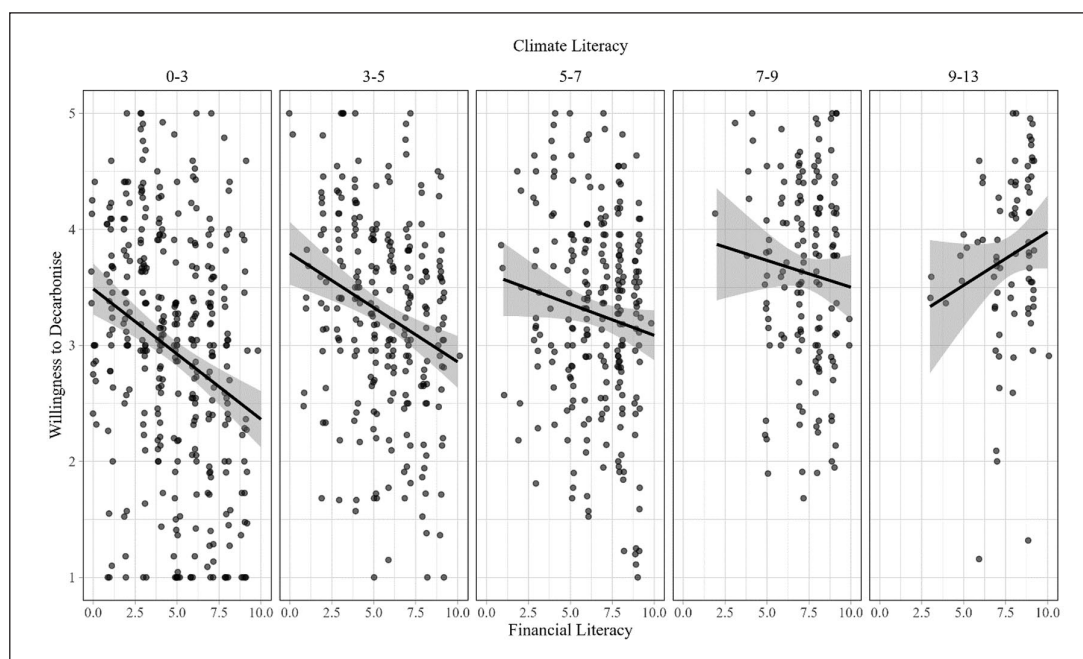


Figure 2. Interaction between climate literacy and financial literacy on willingness to decarbonise.

Note. Financial literacy ranges from 0 to 10, climate literacy ranges from 0 to 13 and willingness to decarbonise ranges from 1 to 5. The dots represent individual participants' financial literacy scores (x-axis) and willingness to decarbonise (y-axis). The black line shows the linear relationship between financial literacy and willingness to decarbonise within each climate literacy subgroup. The shaded region around the line indicates the 95% confidence interval. Each panel represents a subset of participants based on their climate literacy scores, indicated above each panel as 0 to 3, 3 to 5, 5 to 7, 7 to 9 and 9 to 13. For example, the first panel shows that there was a negative relationship between financial literacy and willingness to decarbonise among participants with the lowest climate literacy scores (0–3), whereas the fifth panel shows the relationship turned positive among the participants with the highest climate literacy scores (9–13).

Table 5. Mediation Analyses.

Indirect effects of climate literacy and financial literacy on willingness to decarbonise	Estimate	Std. err.	95% CI [lower, upper]
Climate literacy→Individual efficacy→Willingness to decarbonise	0.030	0.005	[0.020, 0.040]
Climate literacy→Collective efficacy→Willingness to decarbonise	0.011	0.003	[0.006, 0.018]
Financial literacy→Individual efficacy→Willingness to decarbonise	−0.019	0.006	[−0.031, −0.007]
Financial literacy→Collective efficacy→Willingness to decarbonise	−0.004	0.003	[−0.010, 0.000]

efficacy was significant only for those with low levels of environmental values ($b = 0.03$, $SE = 0.009$, 95% CI [0.015, 0.051]), while no moderation effect was observed on the mediating path from climate literacy and collective efficacy (see Table 6).

Finally, environmental values moderated the relationships between financial literacy and both individual and collective efficacy (see Figure 5). The path from individual efficacy to willingness to decarbonise was significantly moderated by environmental values ($b = -0.12$, $F(1, 1,066) = 4.23$, $p < .05$); the path from collective efficacy to willingness to decarbonise showed no significant moderation (see Figure 5). The mediating effect of individual efficacy was significant only for those with low environmental values ($b = -0.06$, $SE = 0.011$, 95% CI [−0.078, −0.035]; see Table 6).

Discussion

Using the data from a representative sample of Australian adults, we tried to understand the role of climate and financial literacy in willingness to decarbonise. The results revealed that climate literacy positively predicted willingness to take decarbonising action, and this was mediated by individual and collective efficacy. This finding

suggests that those with good knowledge of climate change – including its causes, consequences, ways to mitigate it and organisations involved – tend to have a relatively high level of belief that their own and others' efforts can significantly reduce their carbon footprint, as well as successfully address climate change. This belief further encourages them to take decarbonising action. Our finding also replicates the evidence from the literature that climate literacy is a significant factor that motivates decarbonising action, and thus education for a better understanding of climate change is important to encourage consumers to take decarbonising actions (Kolenatý et al., 2022). This is critical considering evidence that individuals are poor at gauging the most impactful decarbonising actions they can take (Camilleri et al., 2019; Johnson et al., 2024).

On the other hand, financial literacy negatively predicted behavioural willingness via decreased individual efficacy. This indicates that those with good knowledge of financial concepts tend to have a relatively low level of belief that their own efforts can successfully address climate change, which may lead them to be less likely to take decarbonising action. These lines of thinking could be based on their primary concern being more related to financial benefits rather than addressing climate change, as they tend to maximise their

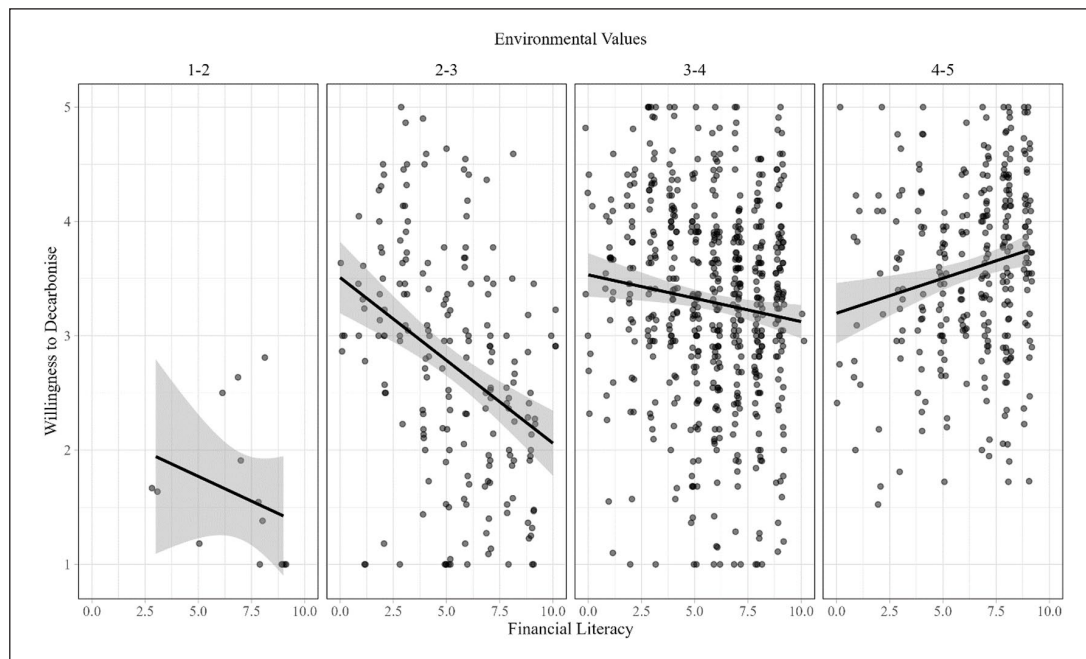


Figure 3. Interaction between financial literacy and environmental values on willingness to decarbonise.

Note: Environmental values range from 1 to 5. The dots represent individual participants' financial literacy scores (x-axis) and willingness to decarbonise (y-axis). The black line illustrates the linear relationship between financial literacy and willingness to decarbonise within each environmental values subgroup. The shaded region around the line shows the 95% confidence interval. Each panel represents a subset of participants based on their environmental values scores, indicated above each panel as 1 to 2, 2 to 3, 3 to 4 and 4 to 5. For example, the first panel shows that there was a negative relationship between financial literacy and willingness to decarbonise among the participants with the lowest environmental values (1–2), whereas the fourth panel shows the relationship between financial literacy and willingness to decarbonise became positive among the participants with the highest environmental values (4–5).

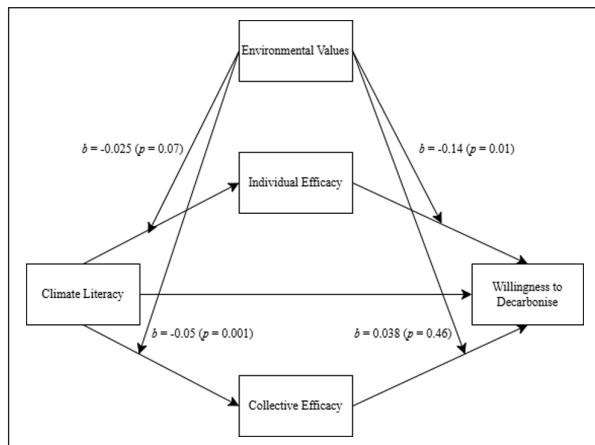


Figure 4. Moderated mediation analysis results: the moderating role of environmental values on the relationship between climate literacy and willingness to decarbonise via individual and collective efficacy.

financial gains and minimise their financial sacrifices (e.g. Cokely et al., 2018).

Environmental values moderated the relationship between financial literacy and willingness to decarbonise. Our findings suggest that individuals with higher environmental values are more likely to overcome the negative impact of financial literacy on their willingness to decarbonise. These results provide supporting evidence for prior research that pro-environmental values can motivate decarbonising action by prioritising environmental well-being over personal gains (Steg & de Groot, 2012). We also found that environmental values moderate the relationships between climate and financial

literacy and willingness to decarbonise, which are mediated by individual efficacy. Collectively, these findings highlight the complex interplay between literacy, efficacy and values in shaping decarbonisation efforts.

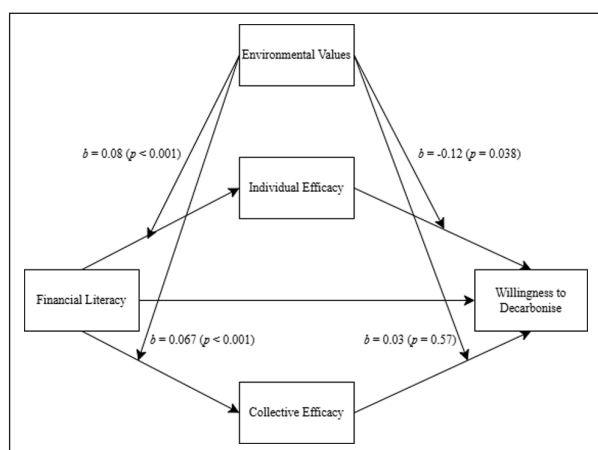
Theoretical implications

We introduced a new measure of climate literacy that incorporates the causes, consequences and mitigation efforts at both individual and collective levels, finding that climate literacy was a significant precursor to willingness to take decarbonising action. In doing so, it confirmed a direct and positive relationship between climate literacy and willingness to decarbonise (e.g. Johnston, 2020).

Importantly, we found evidence that financial literacy was negatively related to behavioural willingness in a large sample of respondents. In contrast, some studies identified a positive correlation between financial literacy and pro-environmental behaviours, such as recycling (e.g. Han et al., 2025; Hasnul & Wasiuzzaman, 2024). This discrepancy may be due to differences in how the decarbonising actions were measured and the sample populations. While Hasnul and Wasiuzzaman (2024) used around 190 youths in a developing country, Brunei, and Han et al. (2025) focused on rural residents in China, our research was conducted with a representative sample of Australian adults. The representative Australian sample, given its higher socioeconomic status and greater exposure to environmental policies and education, offers a potentially more robust context for examining the dynamics between financial literacy and willingness to decarbonise. Furthermore, we used more established and refined measures for both financial literacy and behavioural willingness (e.g. Bradley et al., 2023; Houts & Knoll, 2020). Thus, our findings provide an arguably more comprehensive and reliable understanding of the relationship between financial literacy and willingness to decarbonise.

Table 6. Moderated Mediation Analysis Results.

Path	Environmental values	Estimate	Std. err.	95% CI [lower, upper]
Climate literacy→Individual efficacy→Willingness to decarbonise	–1SD	0.033	0.009	[0.015, 0.051]
	Mean	0.023	0.006	[0.011, 0.033]
	+1SD	0.009	0.006	[–0.002, 0.020]
Climate literacy→Collective efficacy→Willingness to decarbonise	–1SD	0.007	0.004	[–0.001, 0.016]
	Mean	0.005	0.002	[0.001, 0.009]
	+1SD	–0.001	0.003	[–0.006, 0.004]
Financial literacy→Individual efficacy→Willingness to decarbonise	–1SD	–0.055	0.011	[–0.078, –0.035]
	Mean	–0.027	0.006	[–0.040, –0.015]
	+1SD	0.006	0.008	[–0.010, 0.021]
Financial literacy→Collective efficacy→Willingness to decarbonise	–1SD	–0.009	0.005	[–0.021, 0.000]
	Mean	–0.005	0.002	[–0.011, –0.002]
	+1SD	0.002	0.003	[–0.004, 0.010]

**Figure 5.** Moderated mediation analysis results: the moderating role of environmental values on the relationship between financial literacy and willingness to decarbonise via individual and collective efficacy.

Some research suggests a positive relationship between financial literacy and willingness to decarbonise, based on the argument that financially literate consumers are well-positioned to benefit from decarbonisation efforts (e.g. Lusardi & Mitchell, 2011). From this perspective, financially literate individuals might be expected to engage in decarbonising initiatives as they recognise financial advantages such as direct cost savings from reduced energy consumption, increased long-term asset value through sustainable investments (e.g. green superannuation options) and reduced exposure to regulatory or carbon pricing risks. This expectation aligns with benefit segmentation theory (Haley, 1968), which proposes that consumers can be segmented based on the specific benefits they prioritise when making behavioural decisions. Financially literate consumers, in this sense, represent a target segment that would reasonably be receptive to decarbonising initiatives, particularly those that bring potential financial gains or losses.

However, our findings suggest that such benefit-based segmentation may offer a limited insight into financially literate consumer groups and their decarbonisation efforts, as financial acumen does not appear to directly translate into their willingness to decarbonise. We suggest, therefore, that motivational constructs such as perceived individual efficacy should be considered as a central explanatory process within benefit segmentation models.

While previous studies have shown that efficacy can influence pro-environmental behaviours (e.g. Lin & Hsu, 2015), our results provide additional insight into the distinct roles of individual efficacy and collective efficacy (e.g. Jugert et al., 2016). The two forms of efficacy – individual efficacy, the belief in one's own capacity to reduce a personal carbon footprint and address climate change and collective efficacy, the belief in others' capacity to reduce their carbon footprint and address climate change – differently explained the relationship between financial literacy and willingness to decarbonise, providing a deeper understanding. Future studies could focus on distinguishing different levels of efficacy to better target underlying mechanisms and possible interventions.

Our new measure and the insights from our results can be used to help build our understanding of when efforts to induce decarbonisation may or may not work. A potential method for facilitating this integration is to use the 'representational alignment' framework recently proposed by Szollosi et al. (2025). This framework emphasises the need for both cognitive and motivational alignment between an individual and a choice-architect who is trying to drive behaviour change. In terms of decarbonisation efforts, cognitive alignment would be achieved by ensuring that a person has a good factual understanding of the most effective emissions-reducing behaviours. Motivational alignment refers to both parties sharing the same goal of a desired behaviour, such as both seeing the value (financial or otherwise) in driving down individual carbon footprints. By providing a baseline measure of climate literacy – and how it links to other measures such as financial literacy – our work can contribute to efforts for achieving these kinds of alignments.

Practical implications

Despite the acknowledged gap between action and intention (Gifford et al., 2011), the findings from the present research provide practical guidelines on how to motivate consumers' decarbonising action. Throughout the study, we confirmed the critical role of climate literacy in enhancing willingness to decarbonise. Marketing practitioners would benefit from climate literacy education as an intervention to increase the adoption and sales of their decarbonising products, such as electric vehicles and solar batteries. By effectively communicating the positive impact of decarbonising products on reducing carbon footprints and combating climate change, marketers could foster greater consumer engagement and drive higher sales.

At the same time, the negative effect of financial literacy emphasises the need for a different approach in current interventions. For

example, institutions generally educate financial concepts for individuals to enhance their financial well-being (Tahir et al., 2021), however, our results showed that financial literacy was negatively related to their willingness to engage in decarbonising actions. Similarly, emphasising financial benefits of decarbonising behaviours (e.g. ‘. . . rooftop solar, household batteries and electric vehicles . . . will unlock further savings and benefits for all energy customers (\$27.7 million over 4 years)’; Australian Government, 2024b) could result in decreased engagement in those actions, especially for consumers who have weak environmental values. Instead, practitioners may need to enhance consumers’ climate literacy through education, alongside their financial education programmes (Bouman et al., 2021), as our study found that enhanced climate literacy can buffer the negative effect of financial literacy on willingness to decarbonise. For example, Commonwealth Bank Australia, the largest bank in Australia, offers ‘Financial Well-being Seminars’ for its members (Commonwealth Bank Australia, 2024). We suggest these efforts should be accompanied by climate literacy education to mitigate the potential negative impact of financial literacy on willingness to engage in decarbonising actions.

Our results revealed that environmental values moderate the relationship between literacy and perceived efficacy, and thus, interventions to promote decarbonising action could be tailored to consumers’ environmental values. For example, campaigns focusing on building efficacy to bridge the gap between literacy and action could be effective for those with lower environmental values.

While it is well established that consumers with high levels of climate literacy and strong environmental values are more likely to engage with decarbonisation initiatives (e.g. Hu et al., 2025), our findings complicate assumptions about the role of financial literacy. For marketing practitioners, particularly those working in sustainability, this highlights the need for strategic communication tailored to high-financial-literacy segments. Messaging should emphasise efficacy-enhancing narratives, for instance, by providing clear pathways showing how individual actions contribute to broader decarbonisation outcomes. In particular, for those with high levels of financial literacy but low environmental values, campaigns should especially focus on enhancing perceptions of individual efficacy (White et al., 2011). Such framing may help bridge the motivational gap without oversimplifying the message for this audience. However, as our study was based on survey data and correlational analyses, these implications should be interpreted with due caution.

Again, we do not wish to overstate our implications; however, our findings also hold important relevance for branding positioning, particularly for financial institutions that promote sustainable investment products, such as green loans, green deposits and fossil-free super investments, offered by banks, superannuation funds and fintech platforms (e.g. AustralianSuper, 2023; National Australia Bank, 2024). Given that financially literate individuals are likely to represent a core target segment for these institutions, it is important to craft brand narratives that resonate with their financial knowledge and capacity while enhancing their sense of individual efficacy. Brands could further enhance individual efficacy by providing regular feedback on the environmental impact of consumers’ actions. In doing so, these institutions can cultivate efficacy-based brand associations, positioning themselves as platforms that empower individuals to contribute meaningfully to addressing climate change.

Finally, our new measure of climate literacy offers a comprehensive approach, enabling practitioners and scholars to gain a broader view of the public’s understanding of climate change. Our measure could be used to identify gaps in climate change knowledge and inform more effective communication strategies, policies and

education initiatives. For instance, findings from our new climate literacy measure revealed that the knowledge regarding organisations involved in climate action was relatively underdeveloped among participants, with the lowest correct response rate being 21%. This suggests that consumers may lack awareness of the efforts and roles of global institutions and organisations in addressing climate change (e.g. the UN IPCC). Such gaps in knowledge could lead to an underestimation of the importance of collective action and the impact of regulatory and organisational contributions, thereby limiting consumer engagement in broader climate initiatives and climate-related policies. To address this issue, targeted educational programmes focusing on institutional and organisational roles in climate action would be essential to empower consumers to actively participate in global policies and regulations, and support coordinated decarbonisation strategies.

Limitations and future research

Despite its theoretical and practical implications, the present research has limitations. The reliance on a correlational design precludes causal inferences, and the modest effect sizes (e.g. correlation between financial literacy and willingness to decarbonise) suggest that the findings should be interpreted with caution. Hence, further experimental studies are necessary to replicate the findings and make causal conclusions. For instance, an experimental study that manipulates efficacy levels could isolate the relationship between climate literacy and behavioural willingness and buffer the decreased effect of financial literacy on behavioural willingness. Such an experiment might provide a clearer understanding of the nexus between climate and financial literacy and the willingness to decarbonise.

As we found the importance of climate literacy in encouraging decarbonisation, future research should explore the optimal educational programmes for consumers. For example, studies could investigate the most effective content and delivery methods for climate literacy education (Climate Change Education Network, 2024). Additionally, researchers could examine the long-term impact of different educational interventions on consumers’ decarbonising behaviour.

Future research will benefit from exploring potential moderators of the relationship between climate and financial literacy and willingness to take decarbonising action and purchase behaviours. For instance, personal values such as benevolence and universalism could enhance the relationship between climate literacy and behavioural willingness to decarbonise, while hedonism could weaken it (de Groot & Thøgersen, 2018). Additionally, demographic factors such as political ideology and affiliation could serve as another potential moderator (e.g. McCright et al., 2016).

Conclusion

The present research investigated the roles of climate and financial literacy in predicting willingness to decarbonise. In doing so, we introduced a new and comprehensive measure of climate literacy that captures knowledge of the causes, consequences and mitigation of climate change, as well as the roles of organisations involved in climate action. Our findings demonstrated that while climate literacy enhances individuals’ willingness to decarbonise by strengthening their sense of efficacy, financial literacy, in contrast, may undermine this willingness by diminishing individual efficacy, particularly among those with weaker environmental values. These insights offer significant theoretical and practical contributions, underscoring the need to integrate climate literacy education into broader educational

and marketing interventions – alongside financial education – to promote decarbonising action. Finally, our climate literacy measure provides an important basis for identifying gaps in public understanding of climate change, thereby informing more targeted communication strategies and policy initiatives to enhance collective engagement in decarbonisation efforts.

Ethical considerations

This study was approved by the University of Technology Sydney Behavioural Lab Research Ethics Committee (approval no. ETH23-8040) on August 30, 2023.

Consent to participate

Respondents gave consent for review before starting the survey.

Consent for publication

Not applicable.

Data availability statement

The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

Declaration of conflicting interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Notes

1. These concepts are often referred to as *ability efficacy* and *outcome efficacy*. Ability efficacy reflects one's belief in their own or others' capacity to reduce their carbon footprint, while outcome efficacy pertains to the belief that these actions will lead to a desired outcome (Camilleri & Larrick, 2019).
2. The survey included several exploratory variables such as experiences related to climate change, climate persona, climate anxiety, emotions associated with climate change, perceptions of responsibility and trust, perceived barriers to taking decarbonising action, decision-making style and engagement with mitigation-related purchases (such as purchasing solar panels and electric vehicles). Additionally, if participants indicated that they had not yet purchased these products, we asked if they had considered doing so. To focus on providing new insights, variables that are relatively well-documented in the literature (e.g. climate anxiety and climate persona) were not included in the analysis. Other exploratory variables, such as perceptions of responsibility and trust, barriers to taking decarbonising action

and decision-making style, are not discussed in this paper as they were not the primary focus of our study. However, results pertaining to mitigation-related purchase behaviours and purchase intention are reported in Appendices C and D. A correlation table including the continuous variables is also provided in Appendix E. Although perceptions of responsibility and trust, as well as perceived barriers to taking decarbonising action, were measured on Likert-type scales, these items were assessed separately for multiple social actors (e.g. 'banks', 'energy providers', and 'government') and specific barriers (e.g. lack of local infrastructure and disability). As they were not aggregated into a single construct, they were excluded from the correlation table to avoid inflating the number of variables and conflating conceptually non-equivalent measures. All measures used in the study are provided in Appendix F.

3. The results remained the same after controlling for household income level ($b = 0.01$, $F(4, 1,004) = 50.37$, $p < .05$)

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Appendix A

Pilot studies for the development of the climate literacy measure

We conducted five pilot studies, recruiting 50 participants for each study via an online survey platform called ‘TurkPrime’ (Litman et al., 2017)

The goal of the pilot studies was for the average score to be approximately 50% and approximately normally distributed, ensuring an appropriate level of difficulty. However, the initial test appeared too easy for participants, with the average score of 7.68 out of 13 ($SD = 2.88$). As a result, we revised some items to increase their difficulty. For example, an item with a high correct response rate of 83% – meaning that most participants answered correctly – ‘Which of the following is a societal activity that contributes most to causing climate change? (response set: Burning fossil fuels/Making household compost/Producing onshore wind energy/Boiling water and producing water vapour/I don’t know)’ was revised with a different response set: Livestock rearing/Maintaining grassland/Rice farming/Agroforestry/I don’t know.

During the second and third pilot tests, however, the measures turned out to be too difficult for participants, with the average score of 4.36 ($SD = 2.71$) and 4.96 ($SD = 2.11$), respectively. Therefore, we slightly revised some items to make them easier. For instance, an item with a low correct response rate of 22.6% – indicating that only a small percentage of participants answered correctly – asked: ‘Which of the following events are most likely to increase as a result of climate change?’ (response set: Increasing spread of diseases/More frequent light pillars/Ozone layer depletion/Earthquakes/I don’t know). This item was revised with a different response set: Increasing diseases/More frequent volcanic eruptions/More frequent aurora/Radioactive decay/I don’t know.

Our fourth pilot test yielded an average score of 6.22 ($SD = 2.56$). We further refined the scale by replacing questions that were too easy, where the majority of participants responded correctly. For example, an item with an 86% correct response rate, ‘Which of the following events are most likely to increase as a result of climate change?’ (response set: Drought/Geyser/Moonbows (lunar rainbow)/Brinicles (Ice stalactites)/I don’t know) was replaced with a different response set: Drought/Soil acidity/Moonbows (lunar rainbow)/Brinicles (Ice stalactites)/I don’t know.

Finally, we rephrased negative sentences into positive ones and added reference points to the relevant items (e.g. 1 hr) for clarity. The fifth pilot study resulted in the average score of 5.48 ($SD = 3.09$) and approximately in normal distribution (see Figure A1), and this became our final climate literacy measure.

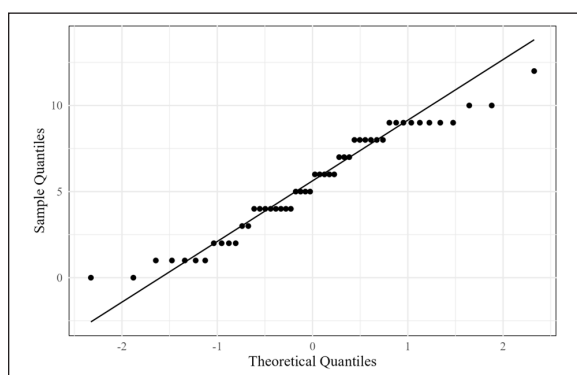


Figure A1. Q-Q plot for pilot study 5 (final items).

Appendix B

Table B1. Descriptive Statistics.

Gender	N	%
Female	539	45.6
Male	542	45.9
Other	1	0.1
Prefer not to say	2	0.2
NA	97	8.2
Education level	N	%
Doctorate	21	1.8
Master's degree	120	10.2
Graduate diploma	48	4.1
Graduate certificate	25	2.1
Bachelor's degree with honours	43	3.6
Bachelor's degree	273	23.1
Associate degree	7	0.6
Advanced Diploma	54	4.6
Diploma	54	4.6
Associate diploma	15	1.3
Advanced certificate	23	1.9
Certificate IV (or post-trade)	46	3.9
Certificate III (or trade)	79	6.7
Certificate II	13	1.1
Certificate I	6	0.5
High school graduate or equivalent	187	15.8
Some high school	70	5.9
NA	97	8.2
Marital status	N	%
Married	496	42.0
Widowed	35	3.0
Divorced	87	7.4
Separated	19	1.6
Never married	320	27.1
Living with partner (De facto)	127	10.8
NA	97	8.2
Employment status	N	%
Employed full time	484	41.0
Employed part time	170	14.4
Unemployed looking for work	32	2.7
Unemployed not looking for work	12	1.0
Self-employed/Freelancer	60	5.1
Retired	230	19.5
Student	36	3.0
Homemaker	43	3.6
Other	17	1.4
NA	97	8.2
Personal income	N	%
Less than \$50,000	411	34.8
\$50,000–\$69,999	169	14.3
\$70,000–\$99,999	210	17.8
\$100,000–\$149,999	161	13.6
\$150,000–199,999	47	4.0
\$200,000–\$299,999	19	1.6
\$300,000 or more	8	0.7
Prefer not to say	59	5.0

(Continued)

Table B1. (Continued)

Gender	N	%
NA	97	8.2
<i>Household income</i>	<i>N</i>	<i>%</i>
Less than \$50,000	219	18.5
\$50,000–\$69,999	146	12.4
\$70,000–\$99,999	170	14.4
\$100,000–\$149,999	224	19.0
\$150,000–\$199,999	151	12.8
\$200,000–\$299,999	78	6.6
\$300,000 or more	29	2.5
Prefer not to say	67	5.7
NA	97	8.2

Appendix C

Results Related to Decarbonising Purchases and Purchase Intention

We asked whether participants had purchased products such as solar panels, an electric car, carbon offsets for travel and sustainable tourism to reduce their carbon footprint. If they indicated that they had not yet purchased these products, we then asked if they had considered doing so (in the binary choice option: yes [coded as 1] or no [coded as 0]). Four items related to their engagement in decarbonising action through purchases were provided, and the average score was used, which ranged between 0 and 1 ($M_{\text{decarbonising purchase}} = 0.19$, $SD = 0.239$; see Appendix H for the full list of items).

If there were decarbonising purchases the participants had not done yet, then we asked their intention to purchase the option. The calculation for the intention was therefore: (the total number of ‘yes’ indications)/4 – (the total number of decarbonising purchase engagements). For example, if the participant had already engaged 3 of the given decarbonising purchases and was willing to take the remaining option, their intention score was 1 (i.e. $1/[4 - 3]$). Those who had engaged all four decarbonising purchases from the option were treated as missing values in this calculation ($N = 22$). The average purchase intention score was 0.36 ($SD = 0.363$). The reliability score for mitigation purchases was 0.51, and the average

purchase intention was 0.66 (see Appendix H for the full list of items).

A parallel mediation analysis using decarbonising purchases as an outcome variable was also conducted. The results with 95% bias-corrected confidence interval based on 5,000 bootstrap samples revealed that climate literacy was indirectly related to decarbonising purchases through its relationships with individual efficacy (total effect: $b = 0.10$, $p < .001$, indirect effect: $b = 0.005$, $SE = 0.001$, CI: 0.003, 0.007). However, collective efficacy was not the significant mediator of this relationship.

The indirect effect of climate literacy on decarbonising purchase intention was also examined. The results with 95% bias-corrected confidence interval based on 5,000 bootstrap samples indicated that climate literacy was indirectly related to mitigation purchases through its relationships with individual ability and outcome efficacy (total effect: $b = 0.03$, $p < .001$, indirect effect: $b = 0.008$, $SE = 0.002$, CI [0.005, 0.011]). However, collective efficacy was not the significant mediator of this relationship.

Financial literacy was not a significant predictor for decarbonising purchases ($b = -0.001$, $F(3, 1,075) = 18.38$, $p > .1$) or purchase intention ($b = 0.001$, $F(3, 1,051) = 23.84$, $p > 0.1$).

Appendix D

Decarbonising Purchase Engagement and Intention Items (Developed by the Authors)

Engagement: Have you previously ever purchased any of the following products? (yes/no)

- Solar panels
- An electric car
- Carbon offsets for travel
- Sustainable or eco-friendly tourism

Intention: Have you considered purchasing any of the following products? (yes/no)

- Solar panels
- An electric car
- Carbon offsets for travel
- Sustainable or eco-friendly tourism

Appendix E

Table E1. Correlations With Exploratory Variables.

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Climate literacy														
2. Financial literacy	.45**													
3. Individual efficacy	.19**	-.09**												
4. Collective efficacy	.18**	-.05	.79**											
5. Environmental values	.40**	.15**	.22**	.27**										
6. Climate anxiety	.21**	-.13**	.53**	.52**	.38**									
7. Direct experience	.08**	-.06*	.17**	.12**	.06	.23**								
8. Indirect experience	.14**	-.02	.21**	.18**	.11**	.28**	.74**							
9. Rational decision style	.20**	.18**	.08**	.08**	.16**	.14**	.02	.05						
10. Intuitive decision style	-.26**	-.27**	.15**	.14**	-.14**	.12**	.07*	.07*	-.08*					
11. Maximisation-search	.15**	.13**	.14**	.17**	.18**	.21**	.03	.07*	.61**	-.07*				
12. Maximisation-outcome	.08**	-.00	.15**	.14**	.09**	.18**	.09**	.12**	.34**	.11**	.33**			
13. Optimism	-.08*	-.08**	.23**	.17**	-.17**	.11**	.03	.03	.03	.23**	.03	.18**		
14. Spendthrift	-.17**	-.20**	.10**	.08*	-.14**	.06	.10**	.06*	-.16**	.23**	-.16**	.03	.14**	
15. Willingness to decarbonise	.29**	-.06*	.67**	.60**	.34**	.59**	.21**	.24**	.08**	.07*	.12**	.13**	.14**	.04

* $p < .05$. ** $p < .01$.

Appendix F

Exploratory survey variables

F1. Direct and Indirect Experience of Climate Change (Bradley et al., 2023)

Direct Experience: Have you directly experienced any of the following types of events in the past 12 months?

Indirect Experience: Have your friends/family directly experienced any of the following types of events in the past 12 months?

1. Heatwave
2. Cyclone
3. Drought
4. Bushfire
5. Flood
6. Some other extreme weather event (please specify)
7. I have not experienced any of the above

F2. Climate Persona (Six Americas Short Survey; Chryst et al., 2018)

1. How important is the issue of climate change to you personally?
(1 = Not at all important, 5 = Extremely important)
2. How worried are you about climate change?
(1 = Not at all worried, 5 = Extremely worried)
3. How much do you think climate change will harm you personally?
(1 = I don't know, 5 = A great deal)
4. How much do you think climate change will harm future generations of people?
(1 = I don't know, 5 = A great deal)

F3. Climate Anxiety Measure (Bradley et al., 2023)

How concerned are you that each of the following threats might directly affect you, your family or your local environment in the foreseeable future?

(1 = Not at all concerned, 5 = Extremely concerned)

1. Bushfires
2. Cyclones
3. Floods (coastal and/or inland)
4. Unemployment
5. Air and water pollution
6. Sea level rise
7. Droughts/Water shortages
8. Heatwaves
9. War/International conflicts
10. Health threats relating to environmental changes or conditions
11. Biodiversity loss (e.g., species extinction, habitat loss)
12. Food insecurity (e.g., crop failures, food shortages, declining agriculture)
13. Terrorism
14. Pandemics
15. Impacts of climate change, generally

F4. Climate Change-Related Emotions Items (Adapted from Hickman et al., 2021)

Does climate change make you feel any of the following? (Check all that apply)

- ☐ Sad
- ☐ Helpless
- ☐ Anxious
- ☐ Afraid
- ☐ Optimistic
- ☐ Angry
- ☐ Guilty
- ☐ Ashamed
- ☐ Hurt
- ☐ Depressed
- ☐ Despair
- ☐ Grief
- ☐ Powerless
- ☐ Indifference
- ☐ Other: _____
- ☐ None of the above
- ☐ Prefer not to say

F5. Perceptions of Responsibility and Trust Items (Developed by the Authors)

Instructions:

- Responsible for causing climate change:
In your opinion, how responsible for causing climate change are the following?
(1 = Not at all responsible, 5 = Extremely responsible)
- Responsible for addressing climate change:
In your opinion, how responsible for addressing climate change are the following?
(1 = Not at all responsible, 5 = Extremely responsible)
- Trust:
In your opinion, when it comes to taking climate action, how **trustworthy** are the following? (1 = Not at all trustworthy, 5 = Extremely trustworthy)

Response set:

- Business/corporations
- Big banks
- Small banks
- Energy providers
- Mainstream media outlets
- The Australian government
- Your State/Territory government
- Your local council
- Your local community
- Your workplace and colleagues
- Your family
- Your friends/peers
- You personally
- Other Australians
- Other countries
- Fossil fuel industry
- Environmental NGOs
- Transport industry
- Agriculture industry
- Construction and infrastructure industry

F6. Perceived Barriers to Decarbonisation Items (Developed by the Authors, Based on Gifford, 2011)

Thinking about lifestyle practices and purchases to live more sustainably and reduce your carbon footprint (for example, by purchasing an electric vehicle, installing solar panels, buying eco-friendly products, recycling, etc.), how much do you agree with the following?

(1 = Strongly disagree, 5 = Strongly agree)

1. Most other people that I know are not engaging in these kinds of behaviours.
2. Most other people that I know do not think doing these kinds of behaviours is the right thing to do.
3. I do not want to be one of the few people engaging in these kinds of behaviours.
4. Changes may cause things to stop working well (e.g., 'green' technology prematurely failing).
5. Changes may decrease my personal safety (e.g., 'green' technology exploding).
6. Changes may render my prior purchases useless (e.g., my current cookware is incompatible with induction cooktops).
7. Changes may not pay for themselves, even in the long run.
8. Changes may be criticised by those around me.
9. Changes may damage how I see myself as a person.
10. Changes may involve wasting a lot of time figuring out what I should do.
11. I have a disability that limits my ability to make such changes.
12. I am unable to make some changes because I do not own the residence I live at.
13. I am unable to save enough to pay large upfront costs associated with some changes.
14. I am unable to access a loan to pay for expensive green purchases.
15. I have limited access to 'green' products even if I was ready to purchase them.
16. It is too complicated for me to install and/or use green technologies.
17. The lack of local infrastructure prevents me from effectively using 'green' products.

F7. Decision Styles Scale (Adapted from Hamilton et al., 2016)

1. Rational decision style: In decision making, I take time to contemplate the pros/cons or risks/benefits of a situation. (1 = Strongly disagree, 5 = Strongly agree)
2. Intuitive decision style: When making decisions, I rely mainly on my gut feelings. (1 = Strongly disagree, 5 = Strongly agree)

F8. Maximisation Items (Adapted from Diab et al., 2008; Turner et al., 2012)

1. Maximisation-Search: I take the time to consider all alternatives before making a decision. (1 = Strongly disagree, 5 = Strongly Agree)
2. Maximisation-Outcome: No matter what it takes, I always try to choose the best thing. (1 = Strongly disagree, 5 = Strongly Agree)

F9. Optimism Item (Adapted from Scheier et al., 1994)

In uncertain times, I usually expect the best. (1 = Strongly disagree, 5 = Strongly agree).

F10. Spendthrift–Tightwad Measure (Adapted from Rick et al., 2007)

Some people have trouble limiting their spending: they often spend money – for example, on clothes, meals, vacations, phone calls – when they would do better not to.

Other people have trouble spending money. Perhaps because spending money makes them anxious, they often don't spend money on things they should spend it on.

Which of the following descriptions fits you better?

(1 = Tightwad [difficulty spending money], 6 = About the same or neither and 11 = Spendthrift [difficulty controlling spending]).

Appendix G

Financial Literacy Scale (Adapted from Houts & Knoll, 2020)

Instruction: In this section of the study, we will ask you questions about financial concepts. Please do your best to select the correct answer. There is no consequence to getting a question wrong. Each question is multiple choice and if you really don't know and don't want to guess, then you can select the option 'I don't know'.

1. Imagine that the interest rate on your savings account was 1% per year and inflation was 2% per year. After 1 year, would you be able to buy more than, exactly the same as or less than today with the money in this account?
 - More than today
 - Exactly the same as today
 - Less than today
 - I don't know
2. If the interest rates rise, what should happen to bond prices?
 - They should rise
 - They should fall
 - They should stay the same
 - I don't know
3. Considering a long time period (for example, 10 or 20 years), which asset described below normally gives the highest return?
 - Savings account
 - Bonds
 - Shares
 - I don't know
4. Normally, which asset described below displays the highest fluctuations over time?
 - Savings account
 - Bonds
 - Shares
 - I don't know
5. When an investor spreads his or her money among different assets, does the risk of losing a lot of money increase, decrease or stay the same?
 - Increase
 - Decrease
 - Stay the same
 - I don't know

6. Do you think the following statement is true or false?
'If you were to invest \$1,000 in a managed fund, it would be possible to have less than \$1,000 when you withdraw your money.'
 - True
 - False
 - I don't know
7. Do you think the following statement is true or false?
'You can purchase life insurance through your super fund.'
 - True
 - False
 - I don't know
8. Do you think the following statement is true or false?
'A 15-year mortgage typically requires higher monthly payments than a 30-year mortgage, but the total interest paid over the life of the loan will be less.'
 - True
 - False
 - I don't know
9. Do you think the following statement is true or false?
'Housing prices in Australia can never go down.'
 - True
 - False
 - I don't know
10. Suppose you owe \$3,000 on your credit card. You pay a minimum payment of \$30 each month. At an Annual Percentage Rate of 12% (or 1% per month), how many years would it take to eliminate your credit card debt if you made no additional new charges?
 - Less than 5 years
 - Between 5 and 10 years
 - Between 10 and 15 years
 - Never, you will continue to be in debt
 - I don't know

Appendix H

Willingness to Take Decarbonising Action Measures (Adapted from Bradley et al., 2023)

To what extent do you agree or disagree with the following statements?

(1 = Strongly Disagree, 5 = Strongly Agree, NA = Not applicable)

To help reduce climate change, I am willing to. . .

1. . . . change my lifestyle
2. . . . greatly reduce my energy
3. . . . pay higher personal taxes
4. . . . pay more electricity
5. . . . pay more for fuel (petrol, diesel, etc.)
6. . . . pay more for energy-efficient products
7. . . . accept cuts in my standard of living
8. . . . take part in a community-wide climate change movement
9. . . . have renewable energy infrastructure such as a solar farm in my local area
10. . . . work with my local community to find ways to adapt to living with climate change

11. . . . wash my clothes in cold (rather than hot) water
12. . . . turn off 'at the wall' appliances like TVs and computers when not in use
13. . . . use public transport more often
14. . . . purchase more of my household's energy through a green power supplier
15. . . . generate my own energy to meet my household's needs, and feed excess energy back into the network/grid
16. . . . get an electric car or a hybrid engine car
17. . . . install solar energy battery storage systems for my home
18. . . . participate in local community projects relating to renewable energy
19. . . . participate in a climate protest, rally or other public demonstrations dedicated to fighting climate change
20. . . . ask the government representatives to take action against climate change
21. . . . switch gas to electric appliances (i.e. stovetops and heaters)
22. . . . install insulation in my home

Appendix I

Efficacy Measures (Developed by Camilleri & Larrick, 2019)

Individual ability efficacy

- How able are **you** to reduce your carbon footprint?
(1 = Completely unable, 5 = Completely able)

Individual outcome efficacy

- If **you** do reduce **your** carbon footprint, to what extent will this contribute meaningfully to addressing climate change?
(1 = No contribution, 5 = Enormous contribution)

Collective ability efficacy

- How able are **others** to reduce their carbon footprint?
(1 = Completely unable, 5 = Completely able)

Collective outcome efficacy

- If **others** reduce **their** carbon footprint, to what extent will this contribute meaningfully to addressing climate change?
(1 = No contribution, 5 = Enormous contribution)

Appendix J

Environmental Values Measure: New Ecological Paradigm (NEP) Scale (Dunlap et al., 2000)

To what extent do you agree or disagree with the following statements?

(1 = Strongly Disagree, 5 = Strongly Agree)

1. We are approaching the limit of the number of people the earth can support.
2. Humans have the right to modify the natural environment to suit their needs (R).
3. When humans interfere with nature it often produces disastrous consequences.

4. Human ingenuity will ensure that we do NOT make the earth unliveable (R).
5. Humans are severely abusing the environment.
6. The earth has plenty of natural resources if we just learn how to develop them (R).
7. Plants and animals have as much right as humans to exist.
8. The balance of nature is strong enough to cope with the impacts of modern industrial nations (R).
9. Despite our special abilities humans are still subject to the laws of nature.
10. The so-called 'ecological crisis' facing humankind has been greatly exaggerated (R).
11. The earth is like a spaceship with very limited room and resources.
12. Humans were meant to rule over the rest of nature (R).
13. The balance of nature is very delicate and easily upset.
14. Humans will eventually learn enough about how nature works to be able to control it (R).
15. If things continue on their present course, we will soon experience a major ecological catastrophe.